ENGINEERING REPORT

of Tom L. Dennis, PE

I. INTRODUCTION

The present Gulf carriers would be able to provide quality offshore service in the Gulf of Mexico Service Area ("GMSA") if they were allowed to use land-based transmitters. The technology exists to engineer and implement land-based cell sites that would serve the GMSA with essentially no interference or Service Area Boundary ("SAB") extension into a land-based carrier's MSA or RSA. Any extension would be far less than the majority of the present de minimis extensions into the GMSA that the Commission has previously granted to the land-based carriers.

II. PURPOSE

The purpose of this report is to examine the status of cellular service in the GMSA, particularly in the areas bordering the coastline, and to formulate a solution that will permit the Gulf carriers to install land-based transmitters without creating interference to the land-based carriers. This solution will rely on existing technology and will present measured technical data to support the conclusions of this report.

III. SUMMARY

- IT IS CLEARLY INAPPROPRIATE TO APPLY THE LAND-BASED PROPAGATION FORMULA TO ALL RADIALS OF LAND BASED TRANSMITTERS LOCATED WITHIN 35 MILES OF THE COASTLINE.

  Because of differences in the land-based and Gulf propagation formulas the "best server line" between Gulf and land-based service areas has been pushed as much as 20 kilometers offshore. The land-based carrier's signals are overpowering the Gulf carrier's signals in the area between the best server line and the coastline. As a result, land-based carriers are serving offshore customers, even in areas where the Gulf carrier has SABs, simply because the land-based carrier is the best server in those portions of the Gulf, not because the area between the best server line and the coastline is unserved by the Gulf carrier.

- CURRENT TECHNOLOGY MAKES LAND-BASED TRANSMITTERS OF GULF CARRIERS PRACTICAL.

  Due to advances in cellular antenna technology it is possible to serve the GMSA with land-based transmitters that have front-to-back ratios that will not significantly interfere with the land-based carrier's service. Through the use of high front-to-back ratio antennas and co-location of the Gulf and land-based transmitters, Gulf carriers will never be the best server on land. In addition, cooperation between the Gulf and land-based carriers can result in both carriers being able to serve their respective areas without unreasonable interference.

- IT IS POSSIBLE TO DRAFT A RULE THAT WILL PERMIT GULF CARRIERS TO LOCATE TRANSMITTERS ON LAND WITHOUT UNREASONABLY INTERFERING WITH THE SERVICE OF LAND-BASED CARRIERS.

  A 6 dB differential in signal strength is all that is required to ensure that one carrier remains the best server in a given area. The Commission could grant Gulf carriers the unilateral right to locate transmitters on land by meeting a simple "Signal Ratio Test." The Signal Ratio Test would require that the Gulf carrier's signal remain 6 dB below the land-based carrier's signal at all points over land, except in the near field. The near field would be defined as the area within 100 meters of co-located transmitters and 250 meters of the Gulf carrier's transmitter, if not co-located with the land-based carrier's transmitter.

IV. DISCUSSION

The land-based carriers have obtained coverage in portions of the GMSA by de minimis extensions and by the change in contour calculation from the Carey 39 dBu contour (defined in FCC report R-6406) to the newer 32 dBu contour. Due to differences in the land and Gulf propagation formulas, the "best server line," where equal signal strengths exist from two carriers, has been forced as much as 20 kilometers offshore. As a result, the Gulf carrier's customers in the area between the best server line and the coastline cannot receive reliable service from the Gulf Carrier. Instead, these customers experience substantial interference from the signal of land-based carriers that "overpowers" the signal from the Gulf carrier, thereby reducing reliable service from the Gulf carrier. These customers would be served by the Gulf carrier, absent the land-based carrier's signal, because the Gulf carrier's propagation contours extend to the shore and would serve this area in the Gulf quite adequately if not "overpowered" by the land-based carrier's existing sites. This area of the GMSA, which is currently within the cellular geographic service area ("CGSA") of the Gulf carriers, could be served by the Gulf carriers if an equitable solution can be identified.

A technical solution exists. Current antenna technology has created cellular antennas with far greater front-to-back ratios than the 27 dB maximum allowed by Section 22.911(a)(4) of the Commission's rules. Section 22.911(a)(4) was developed by incorporating the technology that existed in 1982. If the Gulf carriers were allowed to deploy new antennas along the coastline, the Gulf could be served with essentially no interference or SAB extensions into a land carrier's CGSA. A second benefit would also be realized; the signal strength of both the land-based carrier and the Gulf carrier could be quite strong along the shoreline and still maintain a sharp demarcation whereby the best server line would be slightly offshore. As a result, neither carrier would experience significant interference or loss of territory.

A. THE PRESENT STATUS

The present propagation formulas are contained in Section 22.911 of the Commission's rules:

For land: $d=2.531(h^{0.34})(p^{0.17})$

For water: $d=6.895(h^{0.30})(p^{0.15})$

Where d = the distance in kilometers, h = height in meters, p = radial Effective Radiated Power ("ERP") in watts.

Applying the above formulas to a typical cell site (assume an omni site with 100 watts ERP and a 200 foot antenna elevation above average terrain) results in the following:

A land site will have a calculated SAB radius of 22.4 kilometers.
A Gulf site will have a calculated SAB radius of 47.2 kilometers.

Therefore, a water site with the above parameters has a cell radius 2.1 times as great as an identical land site and covers 4.4 times as much area as a land site. In the above example, the water site covers 7,002 square kilometers whereas the land site covers 1,576 square kilometers.

Actual testing of land-based carriers' cell sites located within 2 kilometers of the shoreline reveals that there is minimal signal loss or shielding from intervening buildings. Measured data from this testing shows that the water formula accurately predicts the limit of the land-based carrier's cell site coverage over water. In short, the land formula simply does not properly show the extent of interference that is being caused to the Gulf carriers by the land-based carriers' cell sites.

The important differences that cause a Gulf site to have a much greater SAB are: (1) The land propagation formula was based on a receiving antenna 6 feet above ground, whereas the Gulf formula is based on a receiving antenna height of 30 feet above water, and (2) The Gulf formula does not include the terrain blockage or man-made noise adjustments that were included in the original Carey 39 dBu calculation and carried over to the present land formula.

A land-based carrier's 32 dBu contour is calculated based on an assumed receiving antenna height of 6 feet. However, the more common receiving antenna height for boats and platforms is 32 feet above water. When measured at 32 feet above water, the land-based carrier's signal is 9 dB stronger than when it is measured at 6 feet above water. In fact, the original signal strength measurements that were made in developing the 32 dBu contour formula were made at 32 feet, but were then adjusted by a 9 dB correction factor to reflect a receiving antenna height of 6 feet. This 9 dB difference equates to approximately 8 kilometers of additional coverage that a land carrier presently has into the Gulf. As a result of the difference in actual receiving antenna height from the height assumed in the land-based propagation formula, the actual service coverage of land-based transmitters extends 8 kilometers further into the Gulf than the propagation formula indicates.

The land-based formula also includes a 14 dB terrain factor to account for signal blockage and attenuation by trees and buildings. However, because of the characteristics of the terrain bordering the Gulf, this 14 dB factor is not appropriate in calculating SABs of cell sites with coverage over the Gulf. Regardless of whether cellular signals are transmitted by a waterborne cell of a Gulf carrier or a land-based transmitter of a land-based carrier, cellular signals propagate over twice as far over water than they do over land with trees and buildings.

For example, a land-based cell site located 22.4 kilometers from the Gulf shoreline would, by current rules, have no de minimis extension into the Gulf. It would, however, have a 24.8 kilometer extension into the Gulf when calculated by the water-based coverage formula. This is particularly true in the usual case where the intervening terrain between the cell site and the shoreline is flat and often consists of salt marsh. Based on actual measured data from testing performed, extensions of this type are real and land-based cells are presently serving offshore customers. Land-based carriers are able to serve offshore customers, even in areas where the Gulf carriers have SABs, simply because the land-based carriers are the best server in those portions of the Gulf, not because this is unserved area. As a result:

> **IT IS CLEARLY INAPPROPRIATE TO APPLY THE LAND-BASED PROPAGATION FORMULA TO ALL RADIALS OF LAND BASED STATIONS LOCATED WITHIN 35 MILES (56.3 KM) OF THE SHORELINE.**

Therefore, all radials (calculated every 10 degrees) from a land-based carrier's transmitter that are located within 35 miles of the shoreline should be recalculated using the water formula and the coverage area re-plotted for the over-water portion. This will more realistically predict the coverage of the land-based carriers over water.

B. ACTUAL STUDIES - THE FLAGSHIP REPORT

Engineering examinations have shown that the closer a shore-based GMSA cell site is located to a land-based carriers cell site the better both the Gulf and land-based carrier can serve their respective areas without interference. A cell site located very near the shoreline, with highly directional antennas, will result in no interference to a co-located land-based carrier if the land-based carrier also uses a directional (or sectored) antenna to serve the shoreline and inland areas. The best server line can be made to be slightly offshore by proper selection of antennas and power levels. A Gulf carrier would then never become best server on land, and the land-based carrier would only be best server for a short distance (0.5 kilometer) offshore. This would be a vast improvement over the current situation where the best server line is up to 20 kilometers offshore.

Recognizing that the best engineering solution was to serve the first 15 kilometers or so of the Gulf from cell sites close to the GMSA border, Coastel performed a feasibility study in May, 1992 for locating a cell site on a pier extending into the Gulf. The cell site, located at the Gulf end of the Flagship Hotel pier in Galveston was, therefore, offshore but had the advantage of shore-based primary power and easy access from conventional streets. This study resulted in an engineering report which was attached to an application for a cell site at the Flagship Hotel pier (the "Flagship Report").

The Flagship Report is appended hereto as Exhibit 3. Although antenna technology has advanced significantly since May 1992, the report does show the feasibility of a non-interfering land-based cell site operated by a Gulf carrier, even with now outdated technology.

The characteristics of the 1992 Flagship installation are shown in detail in the Exhibit 3. The technical parameters were as follows:

1. 100 watts maximum ERP at 145 degrees true.
2. Radiation center 90 feet 8 inches AMSL.
3. Two co-phased panel antennas directed at the Gulf.

The nearest land cell site belonged to GTE and was located approximately 2 kilometers inland and had the following characteristics:

1. 45 watts ERP.

2. Radiation center 200 feet AMSL.

3. Omni-directional antenna.

The Flagship Report (Technical Exhibit) reflects the following:

1. Of 102 measurement locations in Galveston, and along the beach, the Coastel signal was weaker than both the GTE and Houston Cellular signals at 97 of the locations. At three of the locations where Coastel was stronger, it was by less than 1 dB.

2. GTE remained the dominant carrier even on the entry ramp to the Flagship Hotel, only 100 yards behind the Coastel antenna.

3. Even though Coastel was beaming 100 watts ERP into the Gulf with a directional antenna, GTE's omni-directional cell site (about 2 kilometers inland) became "best server" in the Gulf at a distance of two miles offshore and remained best server to the limit of its useful range, about 24.5 miles offshore. This was to a receiving antenna at 6 feet above water. A receiving antenna 32 feet above water would have received a useful signal from GTE to about 31 miles offshore. GTE remained the dominant server because of its greater antenna height, over twice as high as Coastel's test antennas.

The intervening five years since the Flagship report was published have seen numerous improvements in cellular hardware. New antenna designs have become commercially available which feature front-to-back ratios of at least 40 dB. Even without this new technology, the Flagship installation could have been modified slightly to further ensure that it never became best server over land. Unfortunately, Coastel's Flagship site could never have overcome GTE's overpowering offshore signal. Exhibit 1, which is a figure from the original Flagship Report, shows that GTE was always best server at any point more than 2 miles offshore.

C. A REASONABLE SOLUTION

It is recognized that the land-based carriers need a strong signal along the shoreline to serve the beach communities and tourists. This strong signal, however, need not come at the Gulf carriers' expense. Cell sites located on or near the shoreline (*e.g.*, at beach-front hotels) can utilize directional antennas to cover the land area while providing protection to the Gulf. The Gulf carriers, meanwhile, should be afforded the opportunity to use new technology antennas, with actual 40 dB or greater front-to-back ratios, to operate onshore without capturing onshore customers of the land carriers.

D. TECHNOLOGY UPDATE

The FCC presently requires that a maximum of 27 dB front-to-back ratio (or 0.1 watt, whichever is more) be utilized in calculating antenna plots. To some extent, this is based on old technology, was a carry-over from old Section 22.903, and assumes that there will be re-radiation from surrounding structures. An on-shore antenna looking at the Gulf has no buildings or other obstructions to cause re-radiation and effective reduction of the front-to-back ratio. Therefore:

> **THERE IS NO LONGER A REASON TO IMPOSE THE 27 dB RULE ON THE GULF CARRIERS.**

Higher front-to-back ratio antennas are available and in use in the field. Data sheets on several modern log-periodic antennas are included as Exhibit 2 to this report. Each of these antennas have front-to-back ratios of 40 dB or more.

E. CO-LOCATION MAKES LAND-BASED TRANSMITTERS OF GULF CARRIERS PRACTICAL

Co-location is a prime example of technology at work. Given that maintaining the land-based carrier as the best server on land is one of the primary goals, then the land-based carrier should be located as close as possible to any source of competing signal in order to overpower the competing signal. For example, if the land-based carrier and the Gulf carrier share a site on land and if the Gulf carrier has a 40 dB front-to-back ratio antenna, with an 80 degree beamwidth, and if the land-based carrier has a 27 dB antenna with a 90 (or 120) degree beamwidth is there any possibility of the Gulf carrier becoming best server on the backside of the Gulf carriers antenna?

Assuming equal ERPs, there is a 40 dB signal level difference on land to any cellular customer (with equal ERPs, the 40 dB front-to-back ratio of a log periodic antenna puts the GMSA service providers signal at 40 dB below the land carriers signal). About a 6 dB differential is all that is required to ensure that the land carrier remains the best server. As a result:

> **THE GMSA PROVIDER WILL NEVER BECOME BEST SERVER ON THE BACKSIDE (LAND SIDE) OF A CO-LOCATED SITE.**

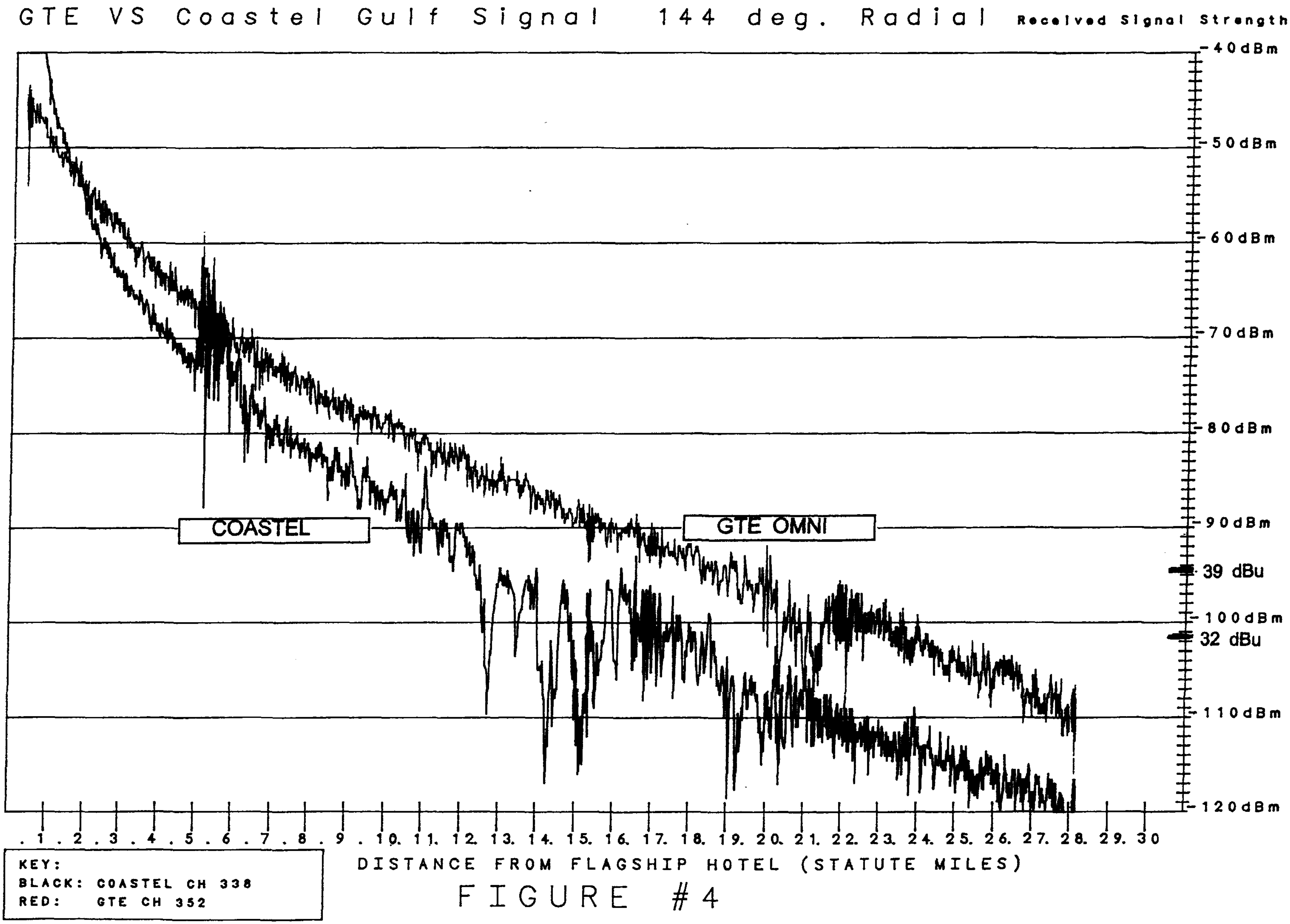
In those instances where co-location near the shore is not possible, the log-periodic type of antenna will still provide enough signal attenuation to the rear to enable operation with minimal problems. Each installation is unique; however, a simple signal ratio rule can be instituted to ensure that no interference will exist. The Flagship Hotel data, where the GTE site was 2 kilometers away, shows that this is a viable plan. Negotiated contracts can cover any instances where there is not a possibility for a well-defined demarcation line. In such situations, experience has taught that land-based carriers must have an incentive to cooperate.

The signal ratio rule can be very simple: the GMSA provider's signal must remain 6 dB below the competing land-based providers signal at all points over land except in the near field. The near field, for purposes of rulemaking, might be taken as 100 meters for co-located sites and 250 meters where the sites cannot be co-located.

IV. CONCLUSION

This report attempts to show that there are engineering solutions that allow both Gulf and land-based carriers to serve their respective areas without potential for anything other than minimal interference. Land based transmitters are, however, a "must" for the Gulf carriers. The optimal solution, and the one that creates the minimum potential for interference, is one that locates the land-based carrier's cell site on the border of a MSA and aims back into the MSA with a highly directional antenna rather than locating the land-based carrier's cell site away from the coastline and aiming out from the MSA. The land-based carriers have, unfortunately, been granted many unnecessary de minimis extensions that have eroded the GMSA. These extensions should be pulled-back to provide a workable platform for the Gulf carriers. The land-based carriers must also learn that they need to locate as near the shoreline as possible and aim back into their MSA just as the Gulf carriers will locate in the same areas and aim into the GMSA. This will result in strong signals from the land-based carriers at the shore highways without capturing cellular calls from platforms 40 miles offshore Though cooperation between the Gulf and land-based carriers, both carriers will be able to serve their respective areas without unreasonably interfering with each other. The Commission must implement rules with the goal of encouraging this cooperation..

Exhibit 1



GTE VS Coastel Gulf Signal 144 deg. Radial
Received Signal Strength
-40dBm
-50dBm
-60dBm
-70dBm
-80dBm
-90dBm
39 dBu
-100dBm
32 dBu
-110dBm
-120dBm
COASTEL
GTE OMNI
.1 .2 .3 .4 .5 .6 .7 .8 .9 .10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30
DISTANCE FROM FLAGSHIP HOTEL (STATUTE MILES)
KEY:
BLACK: COASTEL CH 338
RED: GTE CH 352

FIGURE #4

Exhibit 2

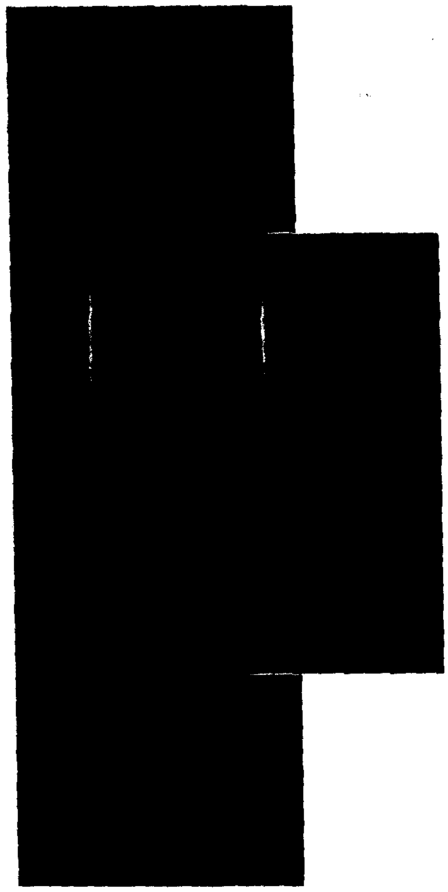
DB842H80N-XY, DB842H90N-XY dB DIRECTOR™ LOG PERIODIC ANTENNAS
DB844H80N-XY, DB844H90N-XY 9-13 dBd GAIN, 40 dB F/B RATIO, 806-960 MHz

Ideal for cellular and trunking/ESMR applications, these high quality log periodics are now available from Decibel in four new models with 80 or 90 degree horizontal apertures. They're compact, lightweight, and provide an **unmatched front-to-back ratio of 40 dB**.

- **Less Wind Loading** - They measure only 24 or 48 inches (610 or 1219 mm) tall, 8.5 inches deep (216 mm), and 6 inches wide (152 mm). They weigh only 5 or 10 pounds.
- **Downtilt** - Electrical downtilt is available on all 4-foot models, 6°, 8°, 11°, 13°, or for mechanical downtilt, order DB5083 bracket.
- **Null-Fill** - Four-foot models provide null-fill and upper lobe suppression.
- **Most Stringent IM Test** - Each antenna is tested for the absence of IM with 16 carriers at 500 watts of composite power.
- **Sturdy Construction** - Made in the U.S. of high-strength aluminum alloy backs, brass elements and UV resistant ABS plastic radomes. No rivets are used!
- **Lightning Resistant** - All metal parts are grounded.
- **Terminations and Mounts** - All models are available with N-Female or 7/16 DIN connectors. DB380 pipe mount is included.

Ordering information - See table for models to fit your requirements.

UPS Shippable



4-Foot and 2-Foot dB DIRECTORS

Models Available

Model*	DB842H80N-XY	DB844H80N-XY	DB842H90N-XY	DB844H90N-XY
Gain – dBd/dBi	10/12.1	13/15.1	9/11.1	12/14.1
F/B Ratio – dB	40	40	40	40
Horizontal beamwidth**	80°	80°	90°	90°
Vertical beamwidth**	30°	15°	30°	15°
Height – in. (mm)	24 (610)	48 (1219)	24 (610)	48 (1219)
Weight – lbs. (kg)	5 (2.3)	10 (4.6)	5 (2.3)	10 (4.6)
Shipping weight – lbs. (kg)	8 (3.6)	15 (6.8)	8 (3.6)	15 (6.8)

* For 7/16 DIN connectors substitute "E" for "N" in the model numbers. Example: DB842H80E-XY.

** 3 dB from maximum.

Side offset mounting bracket is included. For electrical downtilt of 6°, 8°, 11° or 13° add T6, T8, T11 or T13 before the "N" or "E" in any 4-foot model number. Example: DB844H80T6N-XY. Note: Electrical downtilt causes a gain loss of .05 dB, or , at the horizon, a reduction of 3, 6, 9 or 12 dB on downtilts of 6°, 8°, 11° or 13° respectively. For mechanical downtilt order DB5083 bracket.

Mechanical Data

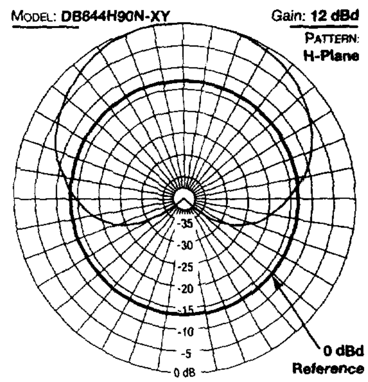
Width – in. (mm)	6 (152)
Depth – in. (mm)	8.5 (216)
Height	See table above
Maximum wind speed – mph (km/h)	125 (200)
Wind area – ft² (m²)	
24" (610 mm) antenna	1 (.093)
48" (1219 mm) antenna	2 (.186)
Wind load (at 100 mph/161 km/h) – lbf (N) kp	
24" (610 mm) antenna	40 (178) 18
48" (1219 mm) antenna	80 (356) 36
Radome	Gray ABS
Backplate	Passivated aluminum
Radiators	Brass
Mounting hardware	Galvanized steel
Weight	See table above

Electrical Data

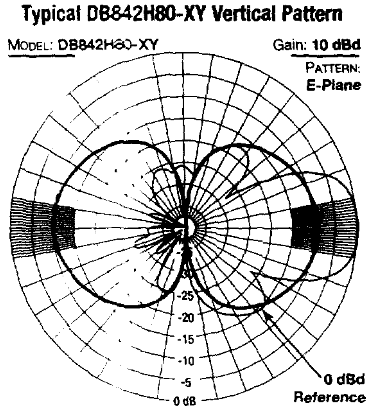
Frequency Range - MHz	806-960
Gain - dBd	See table above
Front-to-back ratio - dB	>40
Beamwidths	See table above
VSWR	<1.5:1
Null-fill and secondary lobe suppression	On 48" (1219 mm) models only
Maximum power input - watts	500
Nominal impedance - ohms	50
Lightning protection	All metal parts grounded
Termination	N-Female or 7/16 DIN

dB DIRECTOR™

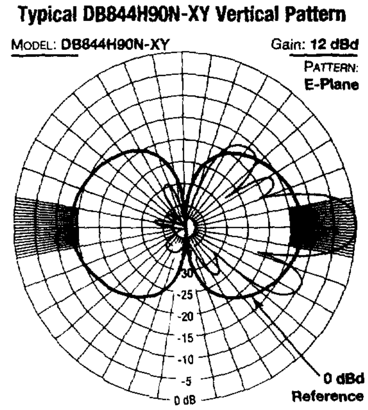
Typical DB842H90N-XY, DB844H90N-XY Horizontal Pattern



Typical DB842H80-XY Vertical Pattern



Typical DB844H90N-XY Vertical Pattern



Celwave Maximizer

Co-Channel Interference is Significantly Reduced

In cellular, PCS and ESMR systems, co-channel interference is the most persistent source of poor performance.

Now interference has been drastically reduced by the new Celwave Maximizer™, a log periodic dipole array that boasts the highest front-to-back ratio ever achieved: 45 dB.

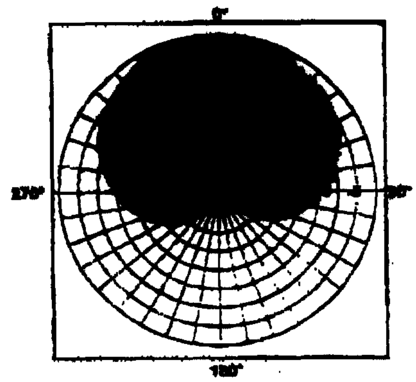
The Maximizer's upper lobe suppression also reduces interference, even during mechanical downtilting. And heavy null fill delivers exceptional close-in coverage.

These benefits are the consequence of superior design, and a manufacturing process that employs Celwave's exclusive monolithic CELite™ technology. A Maximizer antenna has no rivets ... no cables... no soldered joints.

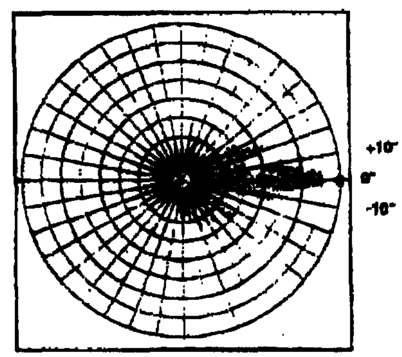
CELite technology assures high reliability, excellent repeatability of electrical characteristics, and a drastic reduction in intermodulation products.

Further, all Maximizer components are surface-treated to prevent galvanic corrosion. The radome is formed from UV-stabilized material that resists deterioration. The result: Year after year of highly reliable, IM-free service, backed by a five-year warranty.

Cellular Maximizers are available in 80° and 90° horizontal beamwidths. PCS Maximizers are available in 65° and 90° beamwidths.



Typical H-plane pattern



Typical E-plane pattern

For analog and TDMA systems, the Maximizer helps to reduce excess overlap and associated unnecessary hand-offs. This can help to reduce bit error rate (BER) in TDMA systems.

The Maximizer Excels in CDMA Systems

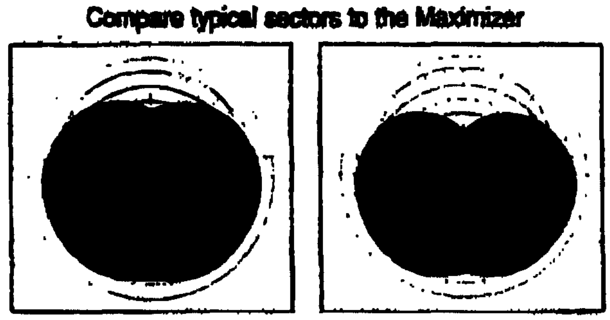
The Celwave Maximizer is the antenna of choice for CDMA systems.

It not only offers the 90° beamwidth that most CDMA operators plan to use, but also a quick H-plane roll -off. These features assure the containment of the soft hand-off zone to give maximum capacity from each site.

Additionally, the 45 dB front-to-back ratio provides extraordinary reduction of co-channel interference, so the re-use factor is as close to one as possible. Thus the Maximizer helps to maximize capacity in CDMA systems by minimizing the cell reuse pattern. Reducing the size of the cells for interference control can be costly. The Maximizer helps optimize q (co-channel interference reduction factor) in CDMA systems, while helping to keep system costs under control.

CDMA operators will also find that the Maximizer provides null fill in the vertical pattern for the superior close-in coverage.

Compare typical sectors to the Maximizer



Typical 120° sector units — The 90° Maximizers

The Maximizer for PCS Systems

ELECTRICAL SPECIFICATIONS	APL190012	APL190014	APL190016	APL196513	APL196516	APL196518
Frequency Range - MHz	1850-1990	1850-1990	1850-1990	1850-1990	1850-1990	1850-1990
Gain - dBd (dBi)	11.5 (13.6)	14.0 (16.1)	16.0 (18.1)	13.0 (15.1)	16.0 (18.1)	17.5 (19.6)
Bandwidth - MHz for 1.5:1 VSWR	140	140	140	140	140	140
Horizontal Beamwidth - Degrees	90	90	90	65	65	65
Vertical Beamwidth 1/2 Power Points - Degrees	15	7	4	15	7	4
Maximum Power Input - Watts	500	500	500	500	500	500
Front-to-Back Ratio - dB	45	45	45	45	45	45
Lightning Protection	Direct Ground	Direct Ground	Direct Ground	Direct Ground	Direct Ground	Direct Ground
Termination - Direct Fixed	7/16 DIN	7/16 DIN	7/16 DIN	7/16 DIN	7/16 DIN	7/16 DIN

Note: All VSWR data referenced to 50 Ohms.

MECHANICAL SPECIFICATIONS	APL190012	APL190014	APL190016	APL196513	APL196516	APL196518
Dimensions-W x D x H - Inches (mm)	4.0 x 4.0 x 24.0 (101.6 x 101.6 x 609.6)	4.0 x 4.0 x 48.0 (101.6 x 101.6 x 1219.2)	4.0 x 4.0 x 69.0 (101.6 x 101.6 x 1828.8)	4.0 x 4.0 x 24.0 (101.6 x 101.6 x 609.6)	4.0 x 4.0 x 48.0 (101.6 x 101.6 x 1219.2)	4.0 x 4.0 x 69.0 (101.6 x 101.6 x 1828.8)
Weight- w/o Mtg. Hardware - lbs. (kg)	3 (1.36)	6 (2.7)	8 (3.6)	3 (1.36)	6 (2.7)	8 (3.6)
Weight- with Mtg. Hardware - lbs. (kg)	5 (2.25)	8 (3.6)	10 (4.5)	5 (2.25)	8 (3.6)	10 (4.5)
Radiating Element Material	Aluminum Alloy	Aluminum Alloy	Aluminum Alloy	Aluminum Alloy	Aluminum Alloy	Aluminum Alloy
Radome Material		UV Stabilized High Impact ABS			UV Stabilized High Impact ABS	
Reflector Material		5052-H32 Aluminum			5052-H32 Aluminum	
Rated Wind Speed - mph (km/hr)	125 (201.25)	125 (201.25)	125 (201.25)	125 (201.25)	125 (201.25)	125 (201.25)
Maximum Wind Loading Area Flat Plate Equivalent - ft² (m²)	.50 (.046)	1.0 (.093)	1.5 (.139)	.50 (.046)	1.0 (.093)	1.5 (.139)
Maximum Thrust @ Rated Wind - lbf (N)	20 (89)	40 (178)	60 (267)	20 (89)	40 (178)	60 (267)
Side Wind Loading Area (FPE) - ft² (m²)	.67 (.062)	1.33 (.124)	2.0 (.186)	.67 (.062)	1.33 (.124)	2.0 (.186)
Side Thrust @ Rated Wind - lbf (N)	26.7 (119)	53.3 (237)	80 (356)	26.7 (119)	53.3 (237)	80 (356)
Mounting Hardware - Supplied	APM18-1	APM19-1	APM19-1	APM18-1	APM19-1	APM19-1
Shipping Dimensions - W x D x H in. (mm)	6.0 x 8.0 x 26.0 (152 x 203 x 660)	6.0 x 8.0 x 50.0 (152 x 203 x 1270)	6.0 x 8.0 x 71.0 (152 x 203 x 1803)	6.0 x 8.0 x 26.0 (152 x 203 x 660)	6.0 x 8.0 x 50.0 (152 x 203 x 1270)	6.0 x 8.0 x 71.0 (152 x 203 x 1803)
Shipping Weight - lbs. (kg)	9 (4.1)	17 (7.7)	21 (9.5)	9 (4.1)	17 (7.7)	21 (9.5)

The Maximizer for Cellular Systems

ELECTRICAL SPECIFICATIONS	APL800010	APL800013	APL800009	APL800012
Frequency Range - MHz	806-894	806-894	806-894	806-894
Gain-dBd (dBi)	10.0 (12.1)	12 (14.1)	9.0 (11.1)	12.0 (14.1)
Bandwidth - MHz for 1.5:1 VSWR	88	88	88	88
Horizontal Beamwidth - Degrees	80	80	90	90
Vertical Beamwidth 1/2 Power Points - Degrees	30	15	30	15
Maximum Power Input - Watts	500	500	500	500
Front-to-Back Ratio - dB	45	45	45	45
Lightning Protection	Direct Ground		Direct Ground	
Termination - Direct Fixed	N-female / 7/16 DIN		N-female / 7/16 DIN	

Note: All VSWR data referenced to 50 Ohms.

MECHANICAL SPECIFICATIONS	APL800010	APL800013	APL800009	APL800012
Dimensions-WxDxH - Inches (mm)	6.0 x 8.0 x 24.0 (152.6 x 203.2 x 609.6)	6.0 x 8.0 x 48.0 (152.6 x 203.2 x 1219.2)	6.0 x 8.0 x 24.0 (152.6 x 203.2 x 609.6)	6.0 x 8.0 x 48.0 (152.6 x 203.2 x 1219.2)
Weight w/o Mtg. Hardware - lbs (kg)	3.24 (1.5)	6.32 (2.87)	3.24 (1.5)	6.32 (2.87)
Weight with Mtg. Hardware - lbs (kg)	4.45 (2.02)	8.2 (3.72)	4.45 (2.02)	8.2 (3.72)
Radiating Element Material	Aluminum Alloy		Aluminum Alloy	
Radome Material	UV Stabilized High Impact ABS		UV Stabilized High Impact ABS	
Reflector Material	5052-H32 Aluminum		5052-H32 Aluminum	
Rated Wind Speed - mph (km/hr)	125 (201.25)	125 (201.25)	125 (201.25)	125 (201.25)
Maximum Wind Loading Area (Flat Plate Equivalent) - ft² (m²)	1.0 (.093)	2.0 (.186)	1.0 (.093)	2.0 (.186)
Maximum Thrust @ Rated Wind - lbf (N)	40 (177.9)	80 (356)	40 (177.9)	80 (356)
Side Wind Loading Area (FPE) - ft² (m²)	1.34 (.124)	2.67 (.248)	1.34 (.124)	2.67 (.248)
Side Thrust @ Rated Wind - lbf. (N)	53.5 (238)	107 (475.9)	53.5 (238)	107 (475.9)
Mounting Hardware - Supplied	APM18-1	APM19-1	APM18-1	APM19-1
Shipping Dimensions - W x D x H in. (mm)	8 x 12 x 26 (203.2 x 305 x 660)	8 x 12 x 50 (203.2 x 305 x 1270	8 x 12 x 26 (203.2 x 305 x 660)	8 x 12 x 50 (203.2 x 305 x 1270))
Shipping Weight - lbs. (kg)	8.5 (3.8)	17.5 (7.87)	8.5 (3.8)	17.5 (7.87)

Celwave Optimizer

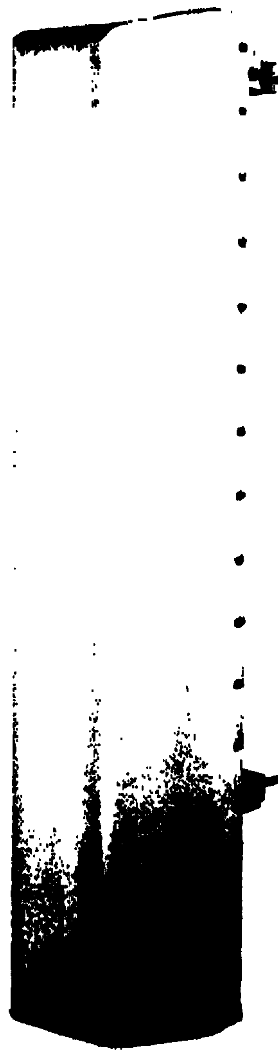
806-941 MHz

Electrically Adjustable Downtilt OPTIMIZER®

ALE869012 **806-941 MHz**

The Celwave Optimizer is a log periodic dipole antenna that improves the performance of ESMR, cellular and paging systems by offering continuously adjustable downtilt from 0 to 14 degrees. The Optimizer employs patented CELlite technology, which eliminates cables and soldered joints, often the cause of reduced system performance due to potential long- term IM issues. The Optimizer has been fully environmentally tested to assure years of trouble-free service.

- **Continuous, dial-turn adjustment of electrical downtilt from 0 to 14 degrees**
- **Minimizes co-channel interference**
- **Adjustable footprint for optimal coverage**
- **Ideal for optimizing performance in simulcast systems**
- **11.5 dBd gain**
- **90 degree horizontal beamwidth**
- **Front-to-back ratio of 40 dB**
- **Exclusive Celwave five-year warranty**



ALE869012 Optimizer Antenna

CELWAVE®
DIVISION OF RADIO FREQUENCY SYSTEMS INC.
2 Ryan Road, Marlboro, NJ 07746-1899 • 1(800) CELWAVE • (732)462-1880

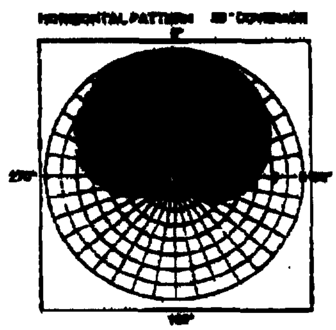
Electrically Adjustable Downtilt OPTIMIZER®

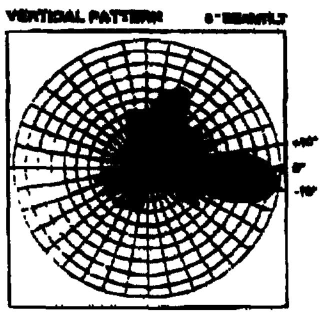
ELECTRICAL SPECIFICATIONS	[illegible]
Frequency - MHz	806-941
Gain - Typ. dBd (dBi)	11.5 (13.6)
Bandwidth - MHz for 1.5:1 VSWR	135
Horizontal Beamwidth - Degrees	90
Vertical Beamwidth @ 1/2 Power Points, Degrees	16
Maximum Power Input - Watts	500
Front-to-back Ratio - dB Typ*	40
Lightning Protection	Direct Ground
3rd Order IMD @ 16 x 41 - dBm	< -100
Termination - Direct Fixed	716 DIN, or Type-N
Electrically Adjustable Downtilt - Degrees	0-14

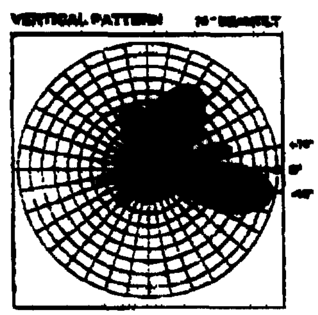
Note: All VSWR data referenced to 50 Ohms

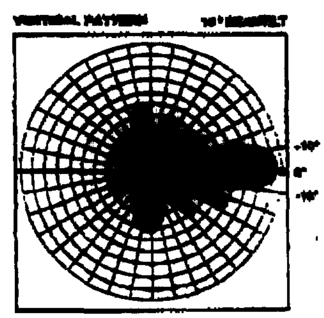
Typ 40 dB 824-894, Typ 32 dB 806-824

MECHANICAL SPECIFICATIONS	
Dimensions - H x W x D- in. (mm)	48.16 x 7.625 x 10 (1223 x 194 x 254)
Weight - lbs. (kg)	18 (8.1)
Radiating Element Material	Aluminum Alloy
Radome Material	UV Stabilized High Impact Plastic
Reflector Material	5052-H32
Rated Wind Speed - mph (km/hr)	100 (161)
Rear Wind Loading Area - Flat Plate Equivalent - ft² (m²)	2.6 (0.242)
Rear Thrust @ Rated Wind - lbf(N)	104 (463)
Side Wind Loading Area (FPE) - ft² (m²)	3.3 (0.307)
Side Thrust @ Rated Wind - lbf (N)	132 (587)
Mounting Hardware - Supplied	10238-5









2 Ryan Road, Marlboro, NJ 07746-1899 • 1(800) CELWAVE • (732)462-1880

Exhibit 3

TECHNICAL EXHIBIT

INTRODUCTION

RVC Services, Inc. d/b/a Coastel Communications Company believed that the actual land incursion would be far less than indicated on the maps contained within the engineering attachments to the FCC Form 401 major modification[1] request. Coastel Communications therefore contracted with Shaffer & Associates, Inc. to perform measurements of the actual signal levels experienced, both on land and in the Gulf of Mexico, from the cell site described in the Form 401. This exhibit summarizes the result of the measurements made on March 31 and April 1, 1992.

OVERVIEW OF METHODOLOGY

A test cell site at the Flagship hotel was installed and operated by Coastel per the parameters contained in the Form 401, i.e. two co-phased Scala Model BP-13-875 directional antennas operating at 100 watts ERP installed at 90' 8" AMSL on the south facing wall of the Flagship hotel per figure 1. Shaffer and Associates examined the installation and witnessed the power level setting. This test installation was operated on an unused signaling channel (ch 338.) The receiving antennas for both the over land and over water measurements were mounted at 6' so that the results could be directly related to the Carey report, R-6406. Literally millions of data points were recorded to disk on three drive tests on the streets of Galveston and three radials into the Gulf of Mexico from the Flagship hotel. All channels were scanned sequentially. The absolute levels of the Coastel, GTE and Galveston Cellular signals were sampled within a few milliseconds of each other and recorded to disk. The detailed engineering section contains further information on the procedures employed in obtaining and displaying the data.

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1. RVC Services, Inc. Application for new or modified Common Carrier Radio Station Authorization in Market No. 306B, Gulf of Mexico, KNKA 412., file number 04837-CL-MP-92

SUMMARY OF RESULTS

A. LAND DATA

The following conclusions result from an examination of the land data.

IT IS UNLIKELY THAT COASTEL WOULD EVER BECOME

BEST SERVER AT ANY POINT ON LAND.

1. Figure 2 is the original 39 dBu contour map. It has been revised by the addition of the shaded area where actual data show the Coastel signal to be outside of the 39 dBu (-94.6 dBm) contour.

2. Out of 102 street intersections identified in the data collected on Galveston Island (the data is displayed in Table 2) the Coastel signal was weaker than <u>both</u> GTE and Galveston Cellular at 97 of these locations.

3. At three of the four locations where the Coastel signal was stronger than GTE, the difference was less than 1 dB.

4. The Coastel signal was weaker than both GTE and Galveston Cellular on the entry ramp to the Flagship hotel.

5. Figure 5 shows the measured points where Coastel did not exceed -39 dBu; Figure 6 shows where Coastel did exceed the 39 dBu contour.

B. WATER DATA

The following conclusions result from an examination of the water data.

THE ACTUAL COASTEL 39 DBU CONTOUR EXTENDS

12.5 MILES INTO THE GULF AND

COVERS THE HOUSTON SHIP CHANNEL

1. Figure 3 shows the Carey predicted 39 dBu contour of the Coastel and GTE cell sites. It also shows the measured 39 dBu contour on three radials for Coastel, GTE and Galveston Cellular.

2. Both GTE and Galveston Cellular have greater coverage areas in the Gulf than Coastel as shown in Figure 3.

3. Table 1 lists the distance to the measured 39 dBu contours on three radials (086°, 144° and 224°) for Coastel, GTE and Galveston Cellular.

4. Figure 4 is a display of signal strength of both Coastel and GTE on the 144° radial from the Flagship hotel. (The 86° and 224° radials are figures 16 and 17).

TABLE 1

Miles from Flagship to measured 39 dBu contour.

Provider	RADIAL		
	86°	144°	224°
Coastel	12.2	12.4	13.0
Galveston Cellular	15.2	14.7	17.0
GTE	18.0	18.7	18.5

GTE AND GALVESTON CELLULAR CLEARLY HAVE STRONGER SIGNALS THAN COASTEL, BOTH OVER LAND AND OVER WATER.

DETAILED ENGINEERING DATA

TEST PROCEDURES

All measurements were made with a cellular test system supplied by LCC. This test system (Model CM-1000) consists of calibrated receivers, both loran C and GPS for position location and a laptop computer for recording all data to disk. The Coastel test transmitter and antenna were installed per the major modification request and operated at 100 watts maximum ERP.

A. LAND DATA

All land measurements were made with 3 dB gain magnetic mount antennas centered on an automobile rooftop with the radiation center at 6'. The coax loss (16' of RG/58) was 2.8 dB; no adjustments were made to the data because the antenna gain and coax loss are essentially equal. Measurements were made and recorded to disk every 3 seconds (20 per minute). Recognizing that one instantaneous measurement might not represent a true average signal level, all of the land data reported in table I represents a log mean average of six data points (three before the marker and three after) and thus represents the statistical average over a fifteen second period as the car moved slowly past the marker point (street intersection). All channels were scanned sequentially, thus the Coastel, GTE and Galveston Cellular signal levels were all recorded within a few milliseconds of each other. Due to the random drive pattern of the car, some intersections were crossed more than one time.

Table 2 is a compilation of all of the land data. Three drive test files were taken; all are reported in table 2.

B. WATER DATA

The same LCC test system was utilized for the water tests. A 20' inboard/outdrive boat with 6 dB gain Celwave antennas mounted vertically with the radiation center 6' above water was utilized so that the data could be related directly to the Carey report (R-6406). The coax loss plus adapter loss was 4.5 dB; no corrections were made to the raw data and every data point (one per second) is represented in the plots of figures 7 through 15. The GPS (Global Positioning Satellite) data was used for all coordinate locations; the distance measurement on the "X"